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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS—FARMERS' INSTITUTE LECTURE NO. 1.
A. C. TRUE, Director.

SYLLABUS

OF

ILLUSTRATED LECTURE

ON

THE CARE OF MILK.

BY

R. A. PEARSON, M. S.,
Cornell University, Ithaca, N. Y.

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PREFATORY NOTE.

This syllabus of a lecture upon The Care of Milk, by R. A. Pearson, M. S., Professor of Dairy Industry in the School of Agriculture of Cornell University, Ithaca, N. Y., is accompanied by 44 lantern slides illustrating the topic. The syllabus and views have been prepared for the purpose of aiding farmers' institute lecturers in their presentation of this subject before institute audiences.

The numbers in the margins of the pages of the syllabus refer to similar numbers on the lantern slides and to their legends as given in the Appendix. Those in the body of the text refer to corresponding numbers in the list of authorities and references.

In order that those using the lecture may have opportunity to fully acquaint themselves with the subject, references to its recent literature are given in the Appendix.

JOHN HAMILTON,
Farmers' Institute Specialist.

Recommended for publication.
A. C. TRUE, *Director.*

Publication authorized.
JAMES WILSON, *Secretary of Agriculture.*

WASHINGTON, D. C., *October 1, 1904.*

THE CARE OF MILK.

By R. A. Pearson, M. S.

The value of the milk and milk products produced in the United States in the last census year, 1900, is given by Alvord as $605,315,354 (1—p. 44).[a] This is greater than the value of the metallic minerals produced in the same year and including pig iron, silver, gold, copper, lead, zinc, and other metals. It is also greater than the total value of nonmetallic minerals produced in 1909 and including bituminous coal, Pennsylvania anthracite, petroleum, natural gas, brick clay, cement, etc.

Undoubtedly the most important use of milk is in its natural form as a human food or as "market milk" (2—p. 5) and (3—p. 3). Almost every individual of our population uses more or less milk and often depends largely upon it for sustenance. But most of the milk produced is used for making butter, while a comparatively small amount is used for making cheese. It is estimated that the amount of milk used as "market milk" (a small part of it condensed) is equivalent to the production of about 7,600,000 cows, the milk used for butter making equals the production of 9,700,000 cows and for cheese making 800,000 cows, making a total of about 18,100,000 cows in the United States.

The profitable production of milk involves two very different kinds of problems: First, how can the farmer form a herd that will give in the milk pail liberal returns for the cost of feed and care? and, second, how should the milk be handled to keep it in the best marketable condition?

I. (*a*) As is well known, there are great differences in the value of cows as milk producers. In the same herd there are often found individuals that do not yield enough to pay for their feed, and others that yield enough milk to pay for feed and care and leave a handsome profit for the owner (4—p. 45). All stages between these extremes are represented. The easiest way to improve the average of a herd is to get rid of the unprofitable cows, and the two best aids for this are milk scales and a Babcock tester, with a carefully kept record of each cow and a determination to relentlessly cull all unpromising stock (5—p. 8). Some of the unprofitable cows can be

[a] Meaning reference book or bulletin No. 1, page 44.

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found without these aids, but the best judges are liable to make mistakes in picking them out. This is largely because the richness of milk can not be told by its appearance.

(*b*) Very many dairy herds would show better returns if they were fed better. Cows giving milk are performing hard
7 work and must be well nourished. If the ration is small, but little of it will be available for making milk after the necessary requirements of supporting life are satisfied. And care must be taken to have the ration include the proper constituents — protein, carbohydrates, and fat—for making milk, repairing tissue wastes, and producing bodily heat (6). It is necessary to carefully study the markets and the possibilities of the farm to be able to obtain feed most cheaply.

(*c*) Health and comfort of the cow and regularity and kindness in her care are also prime requisites for the economical production of milk (5—pp. 10 and 18).

II. The losses suffered by dairy farmers because of improper methods of handling milk amount to a vast sum. Milk is in ideal condition when first secreted in the udder of the healthy, well-kept cow, but if it is not properly cared for it will lose a part or all of its market value soon after it is taken from the udder. The changes of milk are due to bacteria and, if the dairyman understands somewhat the nature and habits of these little creatures, he is greatly aided in protecting himself against their depredations (7—Chap. I) and (8—Chap. I). Bacteria are very abundant in nature. They are minute vegetable organisms and many kinds of them are useful, but some are objectionable and even dangerous. Numerous dif-
8 ferent kinds have been found in milk and some of them have been carefully described and illustrated. Souring is the most common bacterial change of milk and is due to the presence and activity of a large number of germs called lactic-acid germs, that change the sugar of milk into acid (9). Some-
9 times milk undergoes putrefactive changes, or it may become stringy, or bitter, or red, or blue, or it may be affected in many other ways, each different kind of change or fermentation being due to the growth of large numbers of some kind of bacteria. Besides the bacteria that produce marked changes in milk, forms sometimes get into it that retain their life but do not multiply and produce changes, and others that grow more or less rapidly but without producing noticeable changes, although they make the milk unwholesome. Unfortunately

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these latter kinds sometimes include germs that cause disease, and if they once get into a supply of milk they may produce 10
sickness and even death to the consumer. The diseases most liable to be thus carried by milk are typhoid fever, diphtheria, and scarlet fever (8—Chap. V). To be sure, these diseases are not often transmitted by milk, but they have been carried in this way often enough to prove that the possibility and the danger exist. The dairyman, then, should produce and handle his milk in such a way as to exclude all disease-producing or pathogenic bacteria and as many as possible of the forms that cause milk to sour or otherwise deteriorate in value.

How do bacteria get into milk and how can they be excluded? (7—Chap. III), or (8—Chap. II), or (10—p. 13). If the udder is diseased it may be the source of a large number of objectionable bacteria. But a small number of bacteria are in the milk in the healthy udder. They enter through the orifice of the teat and become permanently estab- 11
lished in the teat, milk cistern, and ducts. They are most abundant in the first few streams drawn, and in dairies where every possible precaution is taken to exclude bacteria, it is the rule to discard the first few streams from each teat. Some recent investigations seem to indicate that the contamination of milk from this source is not as serious as once supposed.

The chief source of bacteria in milk is foreign matter which finds its way into milk in greater or less quantities according to the care taken to exclude such contamination. Small particles of soil or manure, hairs, dust, old milk, impure water, etc.—all are carriers of bacteria.

(*a*) The cows should be kept clean. This can be managed easily if the barnyard and stable are kept reasonably clean. 12
The stable air should be as free as possible from dust; the 13
room should have a tight ceiling, no hay nor straw should be 14
stored in it, no dry feed should be given at or just before milk- 15
ing time, and everything which tends to produce dust should be avoided as much as possible.

(*b*) Stables should be well lighted and ventilated both for cleanliness and the health of the animals. The mistake is 16
often made of constructing cow stables with too few windows or none and without provision for ventilation. The newest idea is to admit an abundance of light and to have ventilating 17
shafts to conduct away the most impure air which is nearest 18
the floor and others to admit fresh air near the ceiling (11—

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p. 354). But this system will not work where there are open-
19 ings through which the air can pass outward or inward with-
out control. It is a serious mistake to think that the precau-
20 tions necessary in the stable for the production of pure milk
require the construction of a costly building (12—p. 69).

(*c*) Before milking, the cow should be cleaned, especially
21 those parts from which dirt might fall into the milk pail. A
22 Petri plate (7—p. 41) exposed under a cow whose udder and
surrounding parts are being more or less shaken by the action
of milking, indicates the large number of bacteria dislodged
23 at this time. It does not require much time to brush off the
cows and to wipe the udder and flanks with a damp cloth
24 before milking. Fraser reports (13—p. 593) that 22 times as
much dirt will fall from an udder slightly soiled as from one
that has been washed, and when the udder is muddy the
25 quantity is 90 times as great. Between the cleaning and
milking a cow can be kept standing by a simple device con-
sisting of a chain attached to one side of the stanchion, with
a hook on the end, to be fastened to the other side of the
stanchion under the cow's neck.

(*d*) But with all the care that can be exercised some dirt
and bacteria will be constantly falling where milking is in
26 progress. The common milking pail has a wide open top to
catch a large amount of this falling material. The amount
falling into the milk pail can be greatly reduced by the use of
a pail with a small top (14—p. 5). If the diameter is reduced
to one-half, then the opening will be reduced to one-fourth the
usual size. This can be easily done by using as the milk pail
an ordinary 10-quart serving pail having an opening about 6
inches in diameter. The opening can be still further reduced
27 by the use of a special form of serving pail, one having a visor
attached at one side of the opening and projecting over a part
of it. When the pail is in use the visor is on the upper side,
away from the cow, and the more the pail is tipped toward
the cow the more the opening is protected from falling dirt.
If the visor is high the opportunity for dirt to enter while the
pail is in use is reduced to almost nothing. This kind of
sanitary milking pail seems to have some advantages over
those in which cloth strainers are used. Experience shows
that milkers can soon become accustomed to this style of
pail, and the difficulty of milking into a small opening is not
as serious as at first supposed. A simple experiment will
28 show that milk can be easily drawn into a small opening.

View.

(*e*) So far as possible sharp angles should be avoided in milk utensils because of the difficulty in cleaning such places. 29

(*f*) Persons who milk cows and handle milk should be in good health and under no circumstances come in contact with a person suffering from a contagious disease. A special garment should be worn when milking or handling milk, and hands should be carefully cleaned and kept dry. In dairies where every precaution is taken to keep the milk pure it is customary for attendants to wear white overall suits that are cleaned and sterilized daily. This would be impracticable in the average dairy, but a special garment could be used for milk work and cleaned at frequent intervals without a noticeable increase in the operating expenses. If milkers are expected to keep their hands clean, provision for this should be made in or near the stable. 30 31

(*g*) Immediately after milk is drawn it should be cooled to below 50° F. to prevent the multiplication of the bacteria that have found their way into it (7—p. 47), or (8—p. 100). This can be done by pouring the milk over a cooler or by stirring it in cans set in cold water. If the milk has been taken in a cleanly manner and there is no bad flavor on account of weeds or other flavor producers in the cow's ration, then aeration is not necessary. A good glass floating thermometer should always be at hand. With the aid of Petri plates the effect of different temperatures upon the rapidity of bacterial increase in milk is clearly shown. They increase very slowly below 50° F. 32 33 34

(*h*) Milk should not be handled or stored in the stable (13—p. 606). A separate milk house can be built at small cost, or if this is impracticable, a room can be partitioned off in the corner of the stable most distant from the barnyard. It is well to have but one entrance to this room, and place it so that a person entering from the stable will have to first pass out of doors. 35

Inside the milk room there should be smooth walls and no unnecessary shelves, nooks, and corners for catching dust. 36 37

If milk is to be bottled, this can be done quickly and easily by hand if a small amount, or with a special bottling machine. 38 39

(*i*) The proper cleaning and sterilization of utensils is a matter of great importance (7—p. 27). When there is much of this to be done, special equipment is necessary, but thor- 40

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41 ough work can be performed by hand and with the simplest equipment. It is a great help to have a boiler and steam for sterilizing, but even without this as good results can be obtained by the use of boiling water. Before sterilizing, all utensils should be cleaned by rinsing in warm water, thorough washing in hot water, and rinsing in clean warm or cold water.

42 (*j*) Milk hauled to the station or factory in hot weather should be covered to protect it from heat (10—p. 35). In
43 some places wooden casks are used for carrying milk, but metal or glass is much better because easier cleaned.

Dairy literature is chiefly in the form of a small number of
44 books and bulletins issued during the last few years, besides some periodicals that give all or a part of their space to dairy subjects.

APPENDIX.

LANTERN SLIDES.

No. of view.	LEGENDS.
1.	The distribution of milch cows in the United States. From U. S. Dept. Agr., Bureau of Animal Industry Bul. 55, Pl. I.
2.	The most important use of milk is as a human food. Original.
3.	Most of the milk produced is used for making butter and cheese. Original.
4.	Table showing the annual production and creamery value of the milk of each cow tested through one period of lactation. From Wisconsin Sta. Bul. 75, p. 23.
5.	Milk scales and the Babcock milk tester. Original.
6.	Diagram showing composition of milk. From Wisconsin Sta. Bul. 61, fig. 2.
7.	Table giving the average digestible nutrients in American feeding stuffs. Original.
8.	A variety of bacteria liable to be found in milk. 1 and 2, typhoid bacillus (Pfeiffer); 3, pus and pus cocci; 4, *B. dysenteriæ* (Shigar); 5, *Proteus vulgaris;* 6, *Clostridium butyricus;* 7, 9, 10, 11, types of common lactic bacteria (Conn); 8, a coccus without influence on milk (Conn); 12, 13, 14, three bacilli producing slimy milk (fig. 12, Marshall; figs. 13 and 14, Conn); 15, 16, 17, 18, 19, types of liquefying and putrefying bacteria which digest the casein (Conn). From H. W. Conn's "Bacteria in Milk and Its Products," fig. 16.
9.	Ropy milk. From New York Cornell Sta. Bul. 195, fig. 5.
10.	Graphic representation of a milk epidemic of scarlet fever. A, B, and C are milk producers. 1 and 2 are milk distributers. The circles represent households, the inclosed dots cases of scarlet fever. Upon farm A there was a case of scarlet fever. The diagram shows that milk from farm A gave rise to scarlet fever even when mixed with other milk. From H. W. Conn's "Bacteria in Milk and Its Products," fig. 23.
11.	The interior of the cow's udder. From New York Cornell Sta. Bul. 158, Pl. III.
12.	A badly kept barnyard. From Illinois Sta. Bul. 84, fig. 7.
13.	A well kept barnyard means much for the cleanliness of the milk. From Illinois Sta. Bul. 84, fig. 8.
14.	The air in a stable such as this is constantly filled with dust. From Illinois Sta. Bul. 84, fig. 18.
15.	Tight ceiling and cement floor, sanitary throughout. From S. L. Stewart's Brookside Dairy, Newburgh, N. Y.

No. of view.

16. Cow stable and dairy house improperly located and constructed and poorly cared for.
From U. S. Dept. Agr., Farmers' Bul. 63, fig. 2.

17. A well lighted, modern, sanitary stable.
From Walker-Gordon Laboratory Co., Boston, Mass.

18. The ventilating shaft removes the impure air which is nearest the floor.
From Illinois Sta. Bul. 84, fig. 21.

19. Uncontrolled ventilation.
Original.

20. The barn of a small farmer who made certified milk.
From S. D. Belcher's "Clean Milk."

21. The flanks as well as the udder should be clean.
Original.

22. Fig. 1.—Petri plate exposed two minutes out of doors. Contains 6 colonies.
Fig. 2.—Petri plate exposed two minutes in barn. Contains 111 colonies.
Fig. 3.—Petri plate exposed two minutes under cow being milked. Contains 1,800 colonies.
Figs. 1, 2, and 3 show the extent of the contamination to which milk is exposed from the dust of the barn and the droppings from the belly and udder of the cow.
From "Medical Record," March 28, 1896.

23. Cows should be kept clean.
From U. S. Dept. Agr., 17th An. Rpt. Bureau of Animal Industry, Pl. XXXV.

24. The amount of dirt caught under muddy and slightly soiled udders, before and after cleaning.
From Illinois Sta. Bul. 84, fig. 11.

25. A chain under the neck of the cow will keep her from lying down after being cleaned and before being milked.
Original.

26. The wide-top pail catches too many falling particles of dirt and dust.
Original.

27. The common milking pail; one with smaller top; and the Freeman pail.
Original.

28. Milk can be drawn into a small opening.
Original.

29. The wrong and the right kind of a milk pail.
A, the ordinary type of pail showing sharp angle between sides and bottom; B, the same properly flushed with solder so as to facilitate thorough cleaning. The lower figure represents a joint as ordinarily made in tinware. The depression affords a place of refuge for bacteria from which they are not readily dislodged. This open joint should be filled completely with solder.
From H. L. Russell's "Dairy Bacteriology."

30. A special garment for milking.
Original.

31. A place where the milker can wash his hands.
Original.

32. Cooling the milk.
From Tennessee Sta. Bul., Vol. XV, No. 4, frontispiece.

33. Glass floating thermometer.
Original.

34. Showing the effect of temperature upon bacteria growth.
a, A single bacterium; *b*, its progeny in twenty-four hours in milk kept at 50° F., 5 bacteria; *c*, its progeny in twenty-four hours in milk kept at 70° F., 750 bacteria. Figures taken from an actual experiment.
From H. W. Conn's "Bacteria in Milk and Its Products," fig. 20.

No. of view.

35. A separate milk house.
From Illinois Sta. Bul. 84, fig. 37.

36. Smooth walls in the milk room.
Original.

37. Dust traps in the milk room should not be permitted.
Original.

38. A cheap and clean way of bottling milk.
From Illinois Sta. Bul. 84, fig. 42.

39. Students receiving instruction in milk-bottling in a dairy school.
Original.

40. A pressure sterilizer.
From S. L. Stewart's Brookside Dairy, Newburgh, N. Y.

41. Washing and sterilizing milk cans.
From Illinois Sta. Bul. 84, fig. 28.

42. Farmers delivering milk to the shipping station.
From S. D. Belcher's "Clean Milk."

43. From the mountains—carrying milk to the cheese factory in Switzerland.
From U. S. Dept. Agr., 17th An. Rpt. Bureau of Animal Industry, Pl. XLVI, fig. 1.

44. Some recent books and bulletins upon milk production.
Original.

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Ropiness in Milk and Cream. New York Cornell Sta. Bul. 195.

Tainted or Defective Milks; the Causes and Methods of Prevention. Wisconsin Sta. Bul. 62.

An Inquiry Concerning the Source of Gas and Taint-producing Bacteria in Cheese Curd. New York Cornell Sta. Bul. 158.

Tables for Computing Rations for Farm Animals. New York Cornell Sta. Bul. 154.

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